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Sustainable Agriculture in the Era of the OMICs Revolution

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Editors: [Channa S. Prakash](#), [Sajid Fiaz](#), [Muhammad Azhar Nadeem](#), [Faheem Shehzad Baloch](#), [Abdul Qayyum](#)

Provides in-depth knowledge on mechanisms of OMICs techniques for crop improvement programs

Discusses how to integrate OMICs and novel genome editing technologies for sustainable crop production

Explains how to improve crops via improved yield, quality, and resistance to biotic and abiotic stresses

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About this book

Access to food with enough calories and nutrients is a fundamental right of every human. The global population has exceeded 7.8 billion and is expected to pass 10 billion by 2055. Such rapid population increase presents a great challenge for food supply. More grain production is needed to provide basic calories for humans. Thus, it is crucial to produce 60-110% more food to fill the gap between food production and the demand of future generations.

Meanwhile food nutritional values are of increasing interest to accommodate industrialized modern lives. The instability of food production caused by global climate change presents another great challenge. The global warming rate has become more rapid in

recent decades, with more frequent extreme climate change including higher temperatures, drought, and floods. Our world faces various unprecedented scenarios such as rising temperatures, which causes melting glaciers and the resulting various biotic and abiotic stresses, ultimately leading to food scarcity. In these circumstances it is of utmost importance to examine the genetic basis and extensive utilization of germplasm to develop "climate resilient cultivars" through the application of plant breeding and biotechnological tools. Future crops must adapt to these new and unpredictable environments. Crop varieties resistant to biotic and abiotic stresses are also needed as plant disease, insects, drought, high- and low-temperature stresses are expected to be impacted by climate change. Thus, we need a food production system that can simultaneously satisfy societal demands and long-term development.

Since the Green Revolution in the 1960s, farming has been heavily dependent on high input of nitrogen and pesticides. This leads to environmental pollution which is not sustainable in the long run. Therefore, a new breeding scheme is urgently needed to enable sustainable agriculture; including new strategies to develop varieties and crops that have high yield potential, high yield stability, and superior grain quality and nutrition while also using less consumption of water, fertilizer, and chemicals in light of environmental protection.

While we face these challenges, we also have great opportunities, especially with flourishing developments in omics technologies. High-quality reference genomes are becoming available for a larger number of species, with some species having more than one reference genome. The genome-wide re-sequencing of diverse varieties enables the identification of core- and pan-genomes. An integration of omics data will enable a rapid and high-throughput identification of many genes simultaneously for a relevant trait. This will change our current research paradigm fundamentally from

single gene analysis to pathway or network analysis. This will also expand our understanding of crop domestication and improvement. In addition, with the knowledge gained from omics data, in combination with new technologies like targeted gene editing, we can breed new varieties and crops for sustainable agriculture.

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Keywords

OMICS **Gene editing**

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Transcriptomics

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Dr. Sajid Fiaz, PhD, is an Assistant Professor working at Department of Plant Breeding and Genetics, The University of Haripur, Pakistan. Dr. Fiaz received his PhD in Crop Genetics and Breeding from Chinese Academy of Agricultural Sciences. Dr. Fiaz's research interests include marker assisted selection for agronomic traits, mutation breeding for biotic and abiotic stress resistance, QTL mapping and genome editing for yield and quality traits in cereals. Dr. Fiaz is

actively supervising under-graduate and post-graduate students. He has been awarded with a Start-Up Research Grant Project from Higher Education Commission of Pakistan worth 1.0 Million PKR. He has published more than 95 research, 10 review articles and 10 book chapters with prestigious scientific magazines like International Journal of Molecular Sciences, Frontiers in Plant Sciences, Plant Physiology and Biochemistry and Saudi Journal of Biological Sciences. He is working as academic editor for PLOS ONE, guest associate editor for Frontiers in Plant Sciences, review editor for Frontiers in Genetics and editorial board member for GM Crops and Food. He has recently edited a book, "Principle and Practices of OMICS and Genome Editing for Crop Improvement" with Springer publisher. Currently, his lab group is working to identify genetic factors controlling drought stress tolerance in exotic and local landraces of rice.

Dr. Muhammad Azhar Nadeem is working as an Assistant Professor at Sivas University of Science and Technology, Sivas, Turkey. He received his Ph.D. with a dissertation on 'Identification of Genomic Regions for Various Agronomic Traits in Turkish Common Bean Germplasm with Genome Wide Association Studies (GWAS)' from Department of Field Crops, Faculty of Agricultural and Natural Science, Bolu Abant Izzet Baysal University, Bolu-Turkey. Currently, he is leading and participating in many projects funded by national and international organizations. Moreover, he has supervised one PhD and two master students. He have great skills and expertise in crop science, plant genomics, use of next generation sequencing, DNA molecular markers for germplasm characterization, identification of genomic regions for traits of agricultural interest, development and validation molecular markers for marker assisted selection particularly in cereals and legumes. Currently, he is actively engaging in research activities involving genome-wide association studies (GWAS) for the identification of genomic regions, and their validation through KASP assay for marker-assisted breeding. He

have a good number of research, review articles and book chapters and have more than 1000 citations as per google scholar. He has been serving as an Editorial board member of PLOS ONE, BMC Plant biology, BMC Genomic data, BMC Research Notes, Frontiers in genetics, Molecular Biology reports, Genetic Resources and Crop Evolution and Pakistan Journal of Botany. Moreover, he is serving as a lead editor of upcoming springer book entitled "Legumes biofortification".

Dr. Faheem Shehzad Baloch is working as Associate Professor of plant genetics at Sivas University of Science and Technology, Sivas, Turkey. He received his Ph.D. with a dissertation on 'QTL mapping in wheat' from the faculty of agriculture, University of çukurova, Adana, Turkey in 2012 with a joint fellowship of Turkish ministry of education and Turkish scientific and Technological council of Turkey (TÜBİTAK). In 2013, he started to work as assistant professor at Niğde ÖmerHalis Demir University, Niğde Turkey. In 2015, he joined Bolu Abant izzet Baysal Bolu, Turkey as Assistant professor. In 2018, he promoted to associate professor in the same institute. In August, 2020, he joined Sivas University of science and Technology as associate professor and currently working in the same university. Dr. Faheem has more than 8 years of teaching and research experience in the plant phenomics, genetics and genomics, biotechnology specially in next generation sequencing (NGS) and DNA molecular markers in plant genetics for germplasm characterization, identification of genomic regions for traits of agricultural interest, development and validation of molecular markers for their use in marker assisted selection, and genomic prediction for plant improvement program particularly cereals and legumes. He leaded and participated in many projects funded by national and international organizations. He supervised and co-supervised MSC, PhD and post doc candidates from various countries. He participated in many international trainings on plant molecular genetics particularly at ICARDA-Syria,

Copenhagen University -Denmark, Minnesota University-USA. He has over 100 publications in Web of Sciences database. He has co-edited 6 books and written over 12 book chapters on important aspects of molecular genetics in relation to plant species. He has extensive array of citations with over 2500 times as per google scholar with an h-Index of 26. Dr. Faheem serves as Editorial board member of several impacted journals such as Turkish journal agriculture and forestry, BMC Genomic data, Agronomy Journal. Biotechnology and Biotechnological Equipment, BMC Plant Biology, PLOS ONE and guest editor for special issues in Plants and Molecular Biology Reports and also reviewer for more than 55 peer-reviewed international journals with more than 121 verified reviews according to publons.

Dr Abdul Qayyum is working as an Assistant Professor at Department of Agronomy, The University of Haripur, Pakistan. He received his Ph.D. from Department of Agronomy, Pir Mehr Ali Shah-Arid Agriculture University, Rawalpindi, Pakistan. He is leading and participating in projects both at national and international level moreover, actively supervising master and doctoral level students. Dr. Qayyum's interests include plant physiology, agronomic traits improvement through selection, plant stress response and tolerance mechanism, plant nutrition and nano-technology for cereals. He has published several numbers of research, review articles and book chapters with Agriculture-Basel, Frontiers in Plant Sciences, Saudi Journal of Biological Sciences, Journal of Applied Botany and Food Quality.

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